



# East Waterway Anthropogenic Background

Small Group Meeting #2

Anthropogenic Background

Data Summing and Screening

East Waterway Group

November 16, 2020

# Meeting Agenda

- PCB Summing
- Dioxin/Furan Summing
- Sediment Traps
- Initial Outlier Analysis
- Work products for Meeting #3



# Meeting Schedule

1. Continue AB analysis (*Nov. 20, 10-11:30*)
2. Sensitivity analyses (*Dec. 4, 10-11:30*)
3. Memorandum annotated outline and key tables and figures (*Dec. 9 10-11:30*)
4. Large group meeting (*Jan. 13, 10-12*)

# PCB Summing



# PCB Congener Summing Methods Comparison

Summing Method	n	Mean	Median	90th Percentile	95 UCL on Mean
ND=0.0*RV	58	15.7	8.6	38.8	20.4
ND=0.5*RV	58	15.8	8.7	38.9	20.6
ND=1.0*RV	58	15.9	8.9	38.9	20.6
KM Sum	58	15.7	8.6	38.9	274 (ProUCL selected), 20.2 (ROS)

- ND = non-detected result
- RV = reported value for the non-detected result. Summary statistics based on the sample- and congener-specific non-detected reported value.
- The median number of congener detections per sample was 81%
- Dataset includes all suspended solids samples (centrifuge, filter, and trap)
- UCL 95 based on bootstrap with replacement for the n presented with the exception of the KM-Sum method (next note)
- KM-Sum method based on ProUCL Kaplan Meier non-detect treatment on each sample (i.e., across congeners) with Efron's bias correction. The KM mean or UCL is then multiplied by the number of congeners. The mean, median and 90th percentile summary statistics are on the (KM mean\*# congeners) for samples. The UCL is the mean of (UCL\*# of congeners) for all samples. ProUCL selected UCLs are biased high when an H-UCL is selected; lognormal ROS with 95% BCA bootstrap shown for comparison.

# PCB Aroclor Summing Methods Comparison

Summing Method	n	Mean	Median	90th Percentile	95 UCL on Mean
ND=0.0*RV (or Max RV if all ND)	7	13.8	7.5	31.9	26.7
ND=0.5*RV	7	14.4	8.8	31.9	27.2
ND=1.0*RL	7	15.9	10.0	31.9	28.7

- ND = non-detected result
- RV = reported value for the non-detected result is equal to reporting limit (RL). Summary statistics based on the sample- and Aroclor -specific non-detected reported value.
- Summary statistics shown for Ecology centrifuge dataset. USGS and KC Aroclor data were screened out because they were also analyzed for congeners.
- Totals are based on Aroclors 1248, 1254, and 1260 only, because other Aroclors were ND for all samples.
- UCL 95 based on bootstrap with replacement for the n shown.
- The quantification of Aroclors is based on congener patterns, and there is significant overlap between the patterns for the different Aroclors. Therefore, including a value for the ND Aroclors will over-estimate the total PCBs because the overlapping portion of the patterns will be double-counted.

# Summary Statistics with and without Ecology Aroclor Data

				90th	95 UCL on Mean	
	n	Mean	Median	Percentile	Bootstrap	ProUCL
<b>Congeners and Ecy Aroclors</b>	65	15.5	8.3	41.7	19.9	20.8
<b>Congener Only</b>	58	15.7	8.6	41.7	19.9	20.4

- Summing based on the East Waterway summing methods
  - ND = 0 \* RV for PCB Congeners and Aroclors
  - ND = 0 \* RV of max RV if all Aroclors are ND
- Dataset includes all suspended solids samples (centrifuge, filter, and trap)

# Dioxin/ Furan Summing

# Dioxin/ Furan Congeners Summing Comparison (ng/kg)

Chemical	TEF	n	Det	nd=0*RV		nd=0.5*RV		nd=1.0*RV		Kaplan Meier (ProUCL)	
				Mean	95 UCL	Mean	95 UCL	Mean	95 UCL	KM Mean	95 UCL
1,2,3,4,6,7,8-HpCDD	0.01	59	59	129	157	129	157	129	157	129	161
1,2,3,4,6,7,8-HpCDF	0.01	59	58	28.8	35.5	28.8	35.6	28.9	35.7	28.8	36.9
1,2,3,4,7,8,9-HpCDF	0.01	59	38	1.55	2.02	1.80	2.24	2.04	2.49	1.70	2.26
1,2,3,4,7,8-HxCDD	0.1	59	50	2.30	3.07	2.41	3.15	2.52	3.25	2.39	3.31
1,2,3,4,7,8-HxCDF	0.1	59	53	2.12	2.67	2.15	2.70	2.18	2.72	2.16	2.82
1,2,3,6,7,8-HxCDD	0.1	59	53	5.81	7.20	5.87	7.20	5.92	7.24	5.88	7.48
1,2,3,6,7,8-HxCDF	0.1	59	46	1.21	1.54	1.36	1.67	1.50	1.85	1.30	1.68
1,2,3,7,8,9-HxCDD	0.1	59	53	5.29	6.56	5.42	6.71	5.56	6.80	5.42	6.91
1,2,3,7,8,9-HxCDF	0.1	59	19	0.14	0.23	0.25	0.34	0.37	0.47	0.19	0.31
1,2,3,7,8-PeCDD	1	59	48	1.20	1.49	1.25	1.54	1.30	1.58	1.26	1.59
1,2,3,7,8-PeCDF	0.03	59	46	0.53	0.68	0.57	0.71	0.61	0.74	0.57	0.74
2,3,4,6,7,8-HxCDF	0.1	59	47	1.17	1.47	1.23	1.52	1.28	1.57	1.22	1.58
2,3,4,7,8-PeCDF	0.3	59	48	0.65	0.81	0.73	0.89	0.81	1.00	0.70	0.88
2,3,7,8-TCDD	1	59	44	0.41	0.50	0.45	0.53	0.49	0.57	0.44	0.54
2,3,7,8-TCDF	0.1	59	49	0.65	0.82	0.70	0.87	0.75	0.91	0.69	0.89
OCDD	0.0003	59	59	1,002	1,228	1,002	1,233	1,002	1,233	1,002	1,262
OCDF	0.0003	59	53	75.6	98.1	79.1	101.2	82.7	106.0	78.2	106.2

- ND = non-detected result
- RV = reported value for the non-detected result. Summary statistics based on the sample- and congener-specific non-detected reported value.
- Dataset includes all suspended solids samples (centrifuge, filter, and trap).
- UCL 95 based on bootstrap with replacement for the n presented, with the exception of the Kaplan Meier statistic calculated in ProUCL and based on the ProUCL suggested distribution.

# Dioxin/ Furan Congener Summing Comparison (% Change from $nd = 0.5 \cdot RV$ )

Chemical	TEF	n	Det	nd=0*RV		nd=1.0*RV		Kaplan Meier (ProUCL)	
				Mean	95 UCL	Mean	95 UCL	KM Mean	95 UCL
1,2,3,4,6,7,8-HpCDD	0.01	59	59	0%	0%	0%	0%	0%	2%
1,2,3,4,6,7,8-HpCDF	0.01	59	58	0%	0%	0%	0%	0%	4%
1,2,3,4,7,8,9-HpCDF	0.01	59	38	-14%	-10%	14%	11%	-5%	1%
1,2,3,4,7,8-HxCDD	0.1	59	50	-4%	-2%	4%	3%	-1%	5%
1,2,3,4,7,8-HxCDF	0.1	59	53	-1%	-1%	1%	1%	0%	4%
1,2,3,6,7,8-HxCDD	0.1	59	53	-1%	0%	1%	0%	0%	4%
1,2,3,6,7,8-HxCDF	0.1	59	46	-11%	-8%	11%	11%	-4%	1%
1,2,3,7,8,9-HxCDD	0.1	59	53	-2%	-2%	2%	1%	0%	3%
1,2,3,7,8,9-HxCDF	0.1	59	19	-46%	-34%	46%	37%	-24%	-10%
1,2,3,7,8-PeCDD	1	59	48	-4%	-3%	4%	3%	0%	4%
1,2,3,7,8-PeCDF	0.03	59	46	-7%	-5%	7%	4%	-1%	3%
2,3,4,6,7,8-HxCDF	0.1	59	47	-5%	-4%	5%	3%	0%	4%
2,3,4,7,8-PeCDF	0.3	59	48	-12%	-9%	12%	13%	-4%	-1%
2,3,7,8-TCDD	1	59	44	-9%	-7%	9%	8%	-2%	2%
2,3,7,8-TCDF	0.1	59	49	-7%	-6%	7%	5%	-1%	2%
OCDD	0.0003	59	59	0%	0%	0%	0%	0%	2%
OCDF	0.0003	59	53	-4%	-3%	4%	5%	-1%	5%

- ND = non-detected result
- RV = reported value for the non-detected result. Summary statistics based on the sample- and congener-specific non-detected reported value.
- Dataset includes all suspended solids samples (centrifuge, filter, and trap).
- UCL 95 based on bootstrap with replacement for the n presented, with the exception of the Kaplan Meier statistic calculated in ProUCL and based on the ProUCL suggested distribution.

# Total Dioxin/ Furan and Dioxin/Furan TEQ Summing Comparison (ng/kg)

Chemical	nd=0*RV		nd=0.5*RV		nd=1.0*RV		Kaplan Meier	
	Mean	95 UCL	Mean	95 UCL	Mean	95 UCL	Mean	95 UCL
Total D/F Calculated from Congener Statistics	1,258	1,548	1,263	1,557	1,267	1,562	1,262	1,597
Total D/F TEQ Calculated from Congener Statistics	5.6	6.9	5.8	7.1	6.0	7.3	5.8	7.3
Total D/F TEQ Calculated from Samples	5.6	6.8	5.8	7.0	6.0	7.2	5.8	7.2

- **Row 1:** Calculate mean and UCL for all samples for each congener -> Sum the means and UCLs of congeners
- **Row 2:** Calculate mean and UCL for all samples for each congener -> Sum the (means and UCLs of congeners times the TEF for each)
- **Row 3:** Sum the (concentration \* TEF) for each sample (i.e., TEQ) -> Calculate mean and UCL for all samples

# Total Dioxin/ Furan and Dioxin/Furan TEQ Summing Comparison (% Change from $nd = 0.5 \times RV$ )

Chemical	nd=0*RV		nd=1.0*RV		Kaplan Meier	
	Mean	95 UCL	Mean	95 UCL	Mean	95 UCL
Total D/F Calculated from Congener Statistics	0%	-1%	0%	0%	0%	3%
Total D/F TEQ Calculated from Congener Statistics	-3%	-2%	3%	3%	0%	3%
Total D/F TEQ Calculated from Samples	-3%	-3%	3%	3%	0%	2%

- **Row 1:** Calculate mean and UCL for all samples for each congener -> Sum the means and UCLs of congeners
- **Row 2:** Calculate mean and UCL for all samples for each congener -> Sum the (means and UCLs of congeners times the TEF for each)
- **Row 3:** Sum the (concentration \* TEF) for each sample (i.e., TEQ) -> Calculate mean and UCL for all samples



# Summing Methods EWG Recommendations

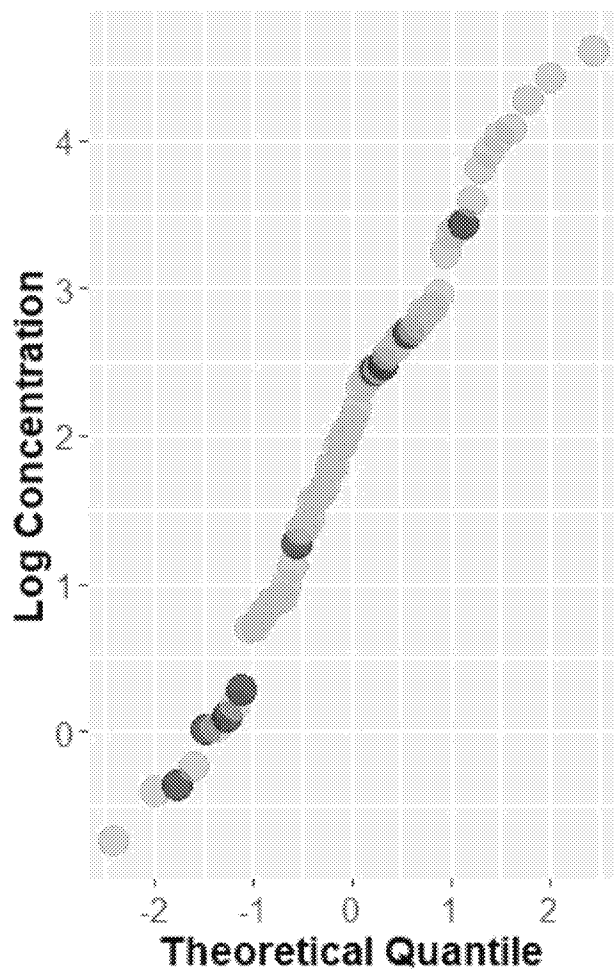
# EWG Recommendations

- PCB Congeners
  - Use  $0 \times \text{RV}$  for non-detects (same as EW SRI/FS)
- PCB Aroclors
  - Keep Ecology Aroclor data
  - Use  $0 \times \text{RV}$  for non-detects (if all ND, max of RVs) (same as EW SRI/FS)
- Dioxins/Furans
  - Dioxins/furans TEQ ( $1/2 \times \text{RV}$  for non-detects)
    - same as EW SRI/FS
    - TEQ is a weighted sum approach to account for congeners of most concern based on their toxic equivalency to 2,3,7,8-TCDD

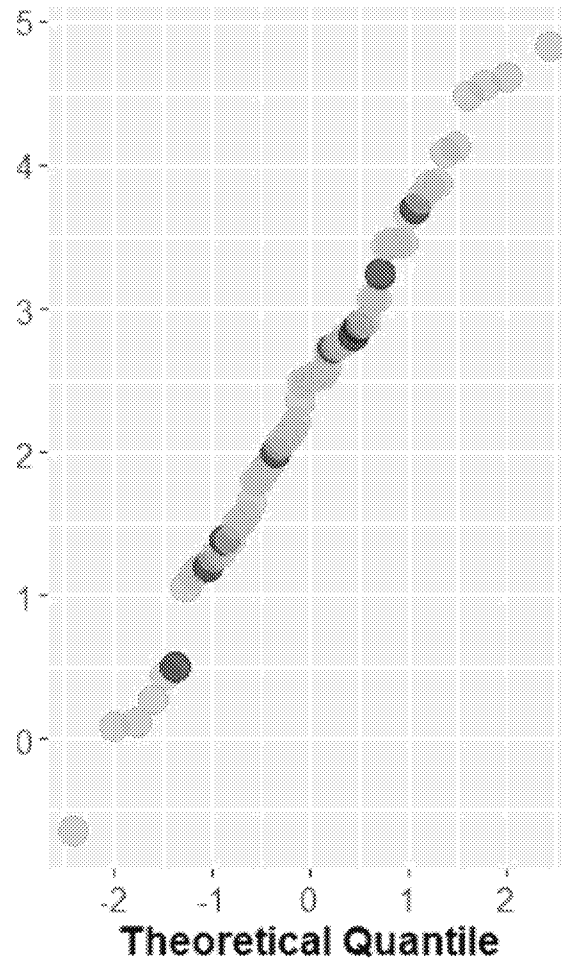
# Sediment Traps

# Total PCBs (ug/kg) QQ Plots with Sediment Trap Data

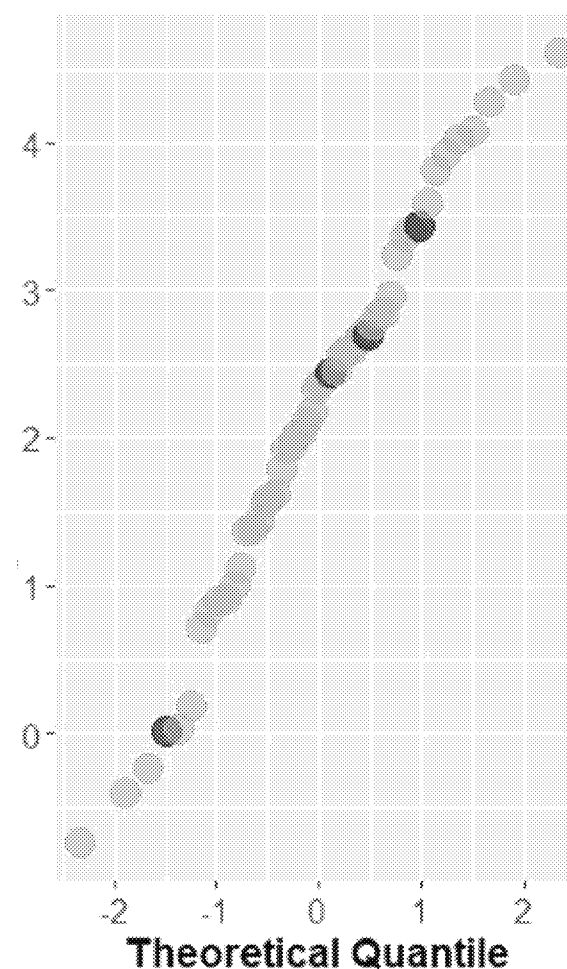
All Suspended Solids



All Fines Normalized



>60% Fines



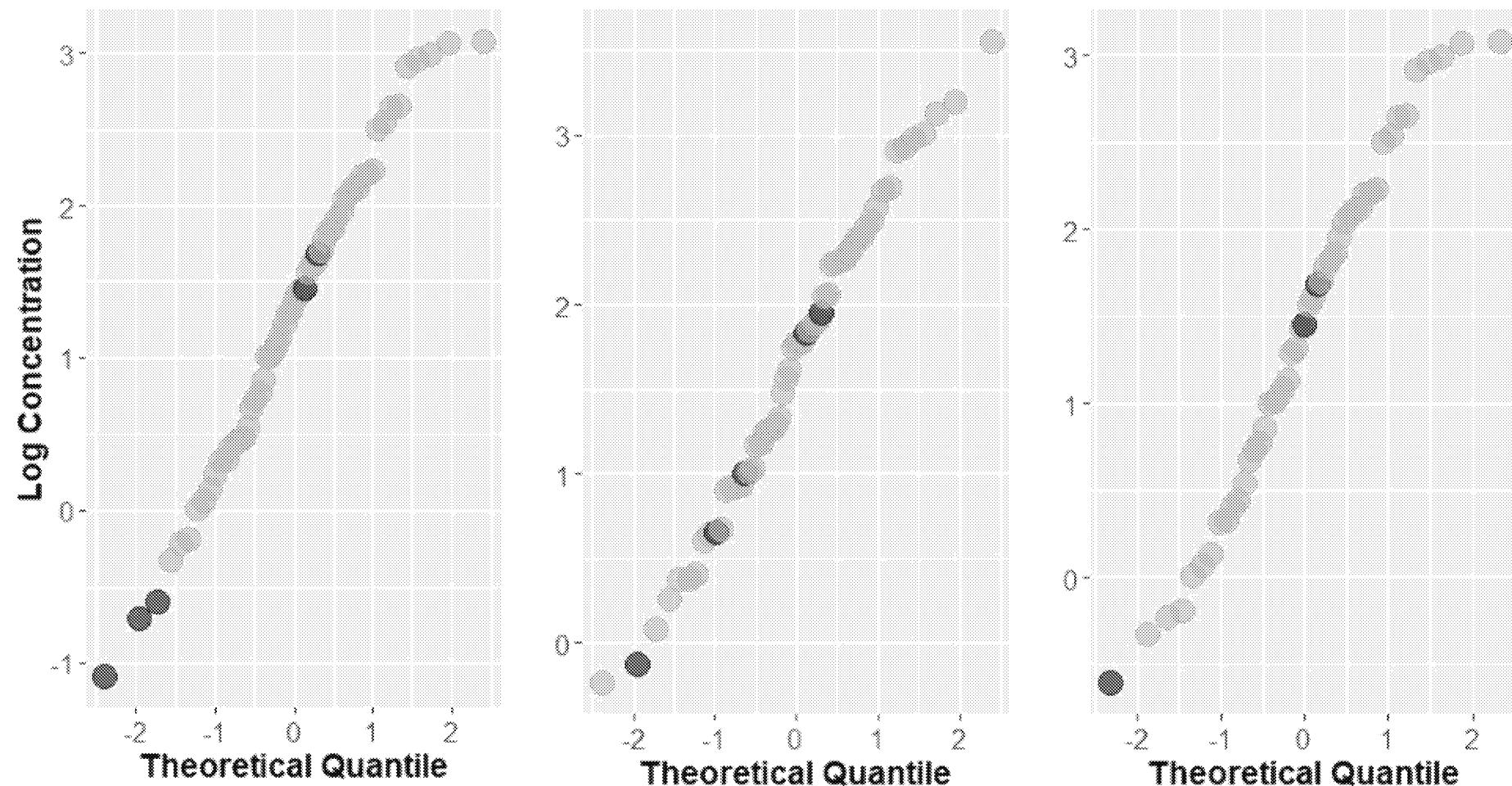
- Green = Centrifuge or Filter Solids
- Blue = Sediment Trap

# Dioxin/Furan TEQ (ng/kg) QQ Plots with Sediment Traps

All Suspended Solids

All Fines Normalized

>60% Fines



- Green = Centrifuge or Filter Solids
- Blue = Sediment Trap

# Arsenic (mg/kg) QQ Plots with Sediment Traps



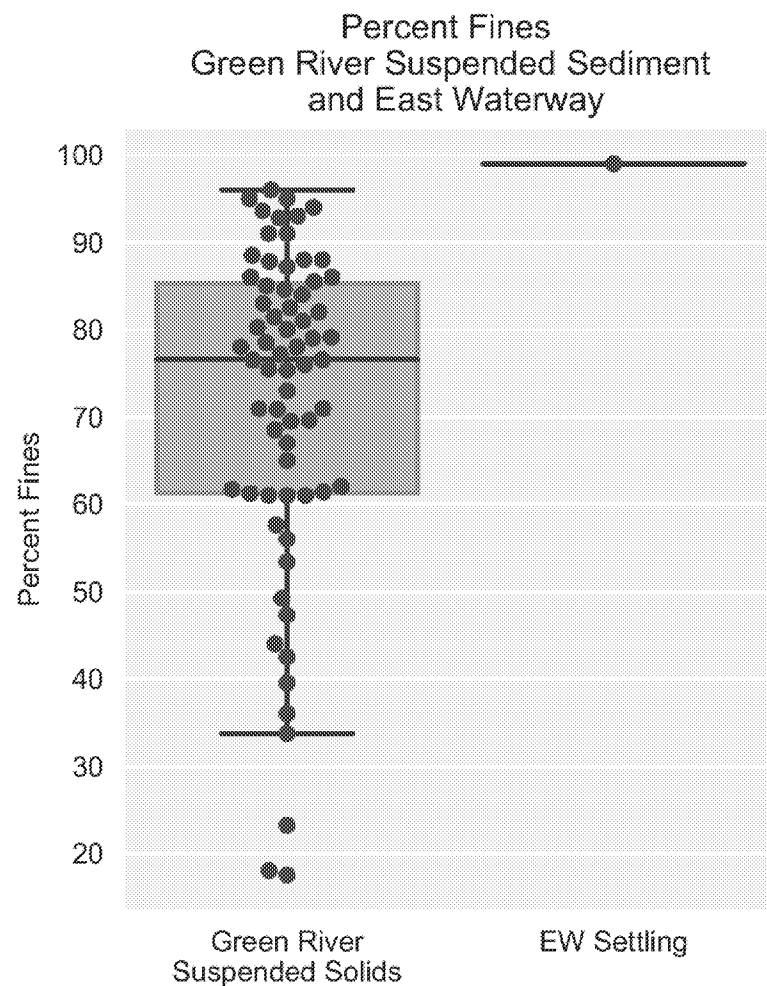
# Summary Statistics for Sediment Trap Sample Adjustments

Chemical	Samples	n	Mean	UCL 95
Total PCBs (ug/kg)	Include Sediment Traps	65	15.5	19.9
	Exclude Sediment Traps	56	16.6	21.5
	Fines-normalize (All Samples)	65	20.7	26.1
	Screen Samples < 60% Fines	52	17.8	23.1
Dioxin/furan TEQ (ng/kg)	Include Sediment Traps	59	5.8	7.0
	Exclude Sediment Traps	54	6.1	7.4
	Fines-normalize (All Samples)	59	7.6	9.2
	Screen Samples < 60% Fines	49	6.4	7.8
Arsenic (mg/kg)	Include Sediment Traps	61	16.2	18.0
	Exclude Sediment Traps	52	17.2	19.3
	Fines-normalize (All Samples)	61	23.2	25.7
	Screen Samples < 60% Fines	49	17.4	19.5

- Fines-normalized Concentration= Concentration / (Percent Fines /100)

# Sediment Trap Data Observations

- Sediment traps are from a different population than centrifuge and filter solids.
- Fines-normalizing and/or screening has a basis in the CSM and would allow more samples to be included in the dataset for straight summing
- Sediment traps would have to be removed from any flow weighted approach



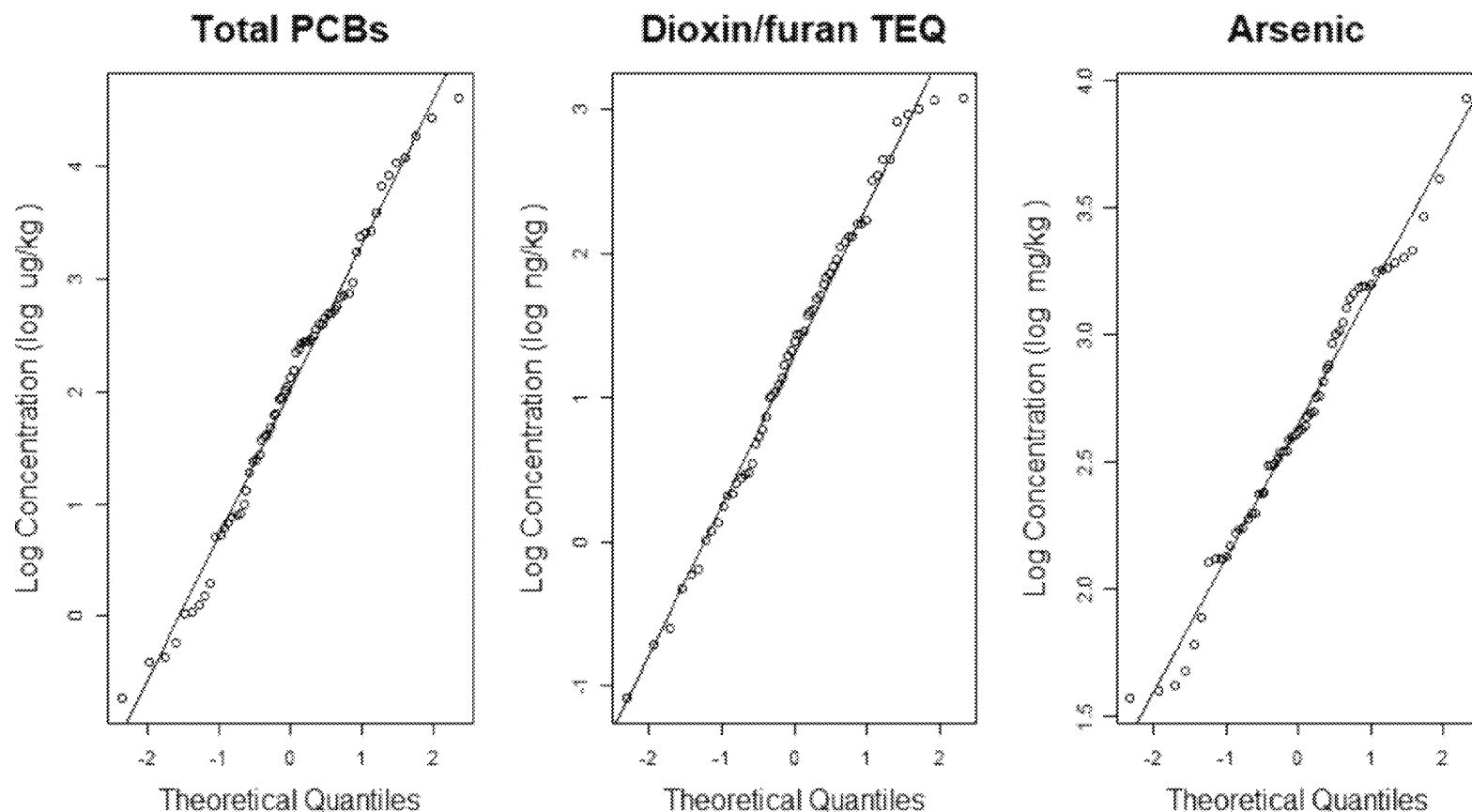


# Initial Outlier Analysis

# Outlier Analysis

- *Outliers are measurements that are unusually larger or smaller than the remaining data. They are not representative of the sample population from which they were drawn (US EPA, 2002)*
- A quantitative outlier test indicates no outlier; concentrations are consistent with lognormal distributions
- However, representativeness of high values is evaluated further in the context of the sample population and river conditions

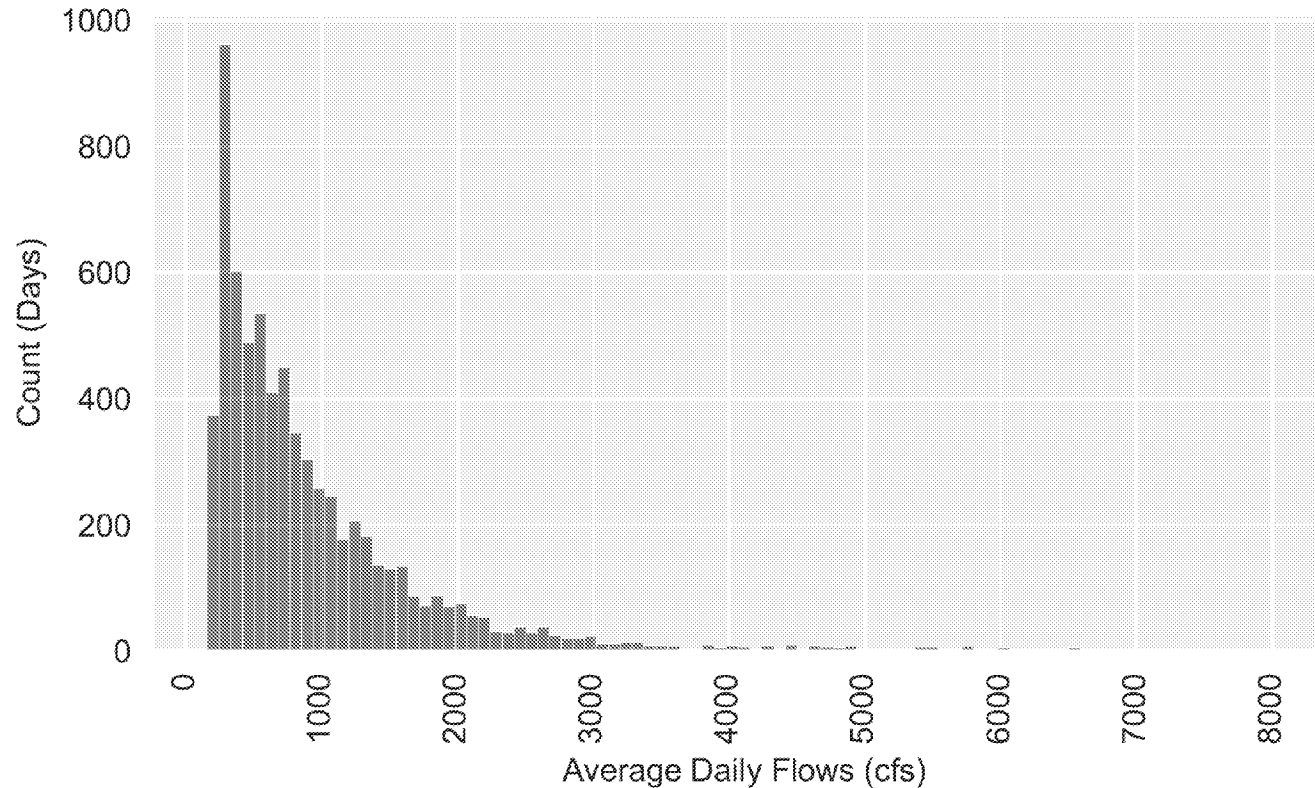
# Concentration Distributions



- Distribution includes sediment trap data
- Total PCBs include Ecology Aroclor samples

# River Conditions

Distribution of Average Daily Flows (cfs)  
Below the Howard Hanson Dam 2001 - 2019

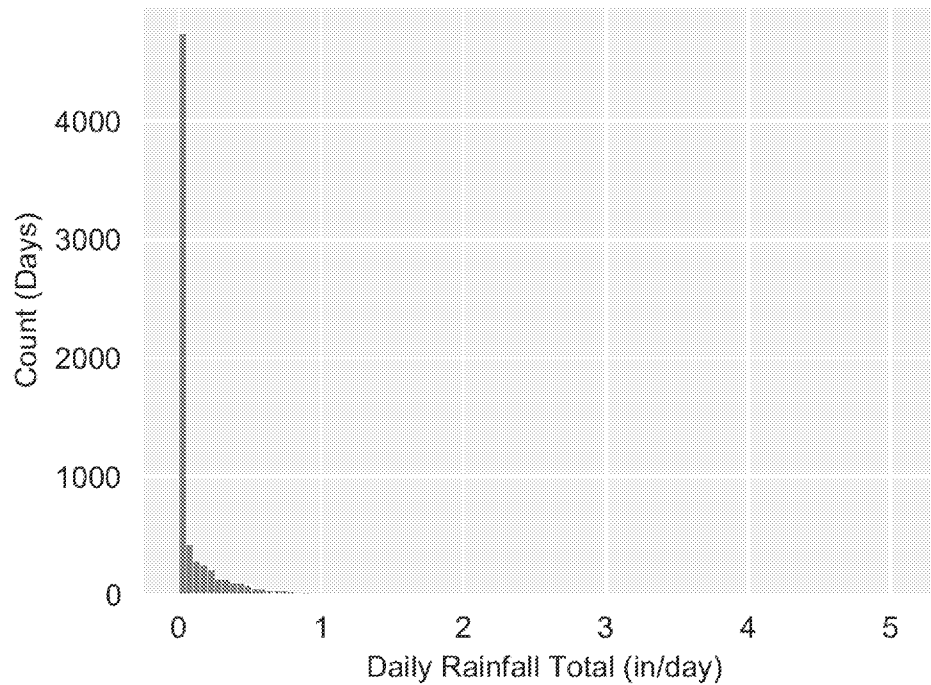


## Daily Average Flow (cfs)

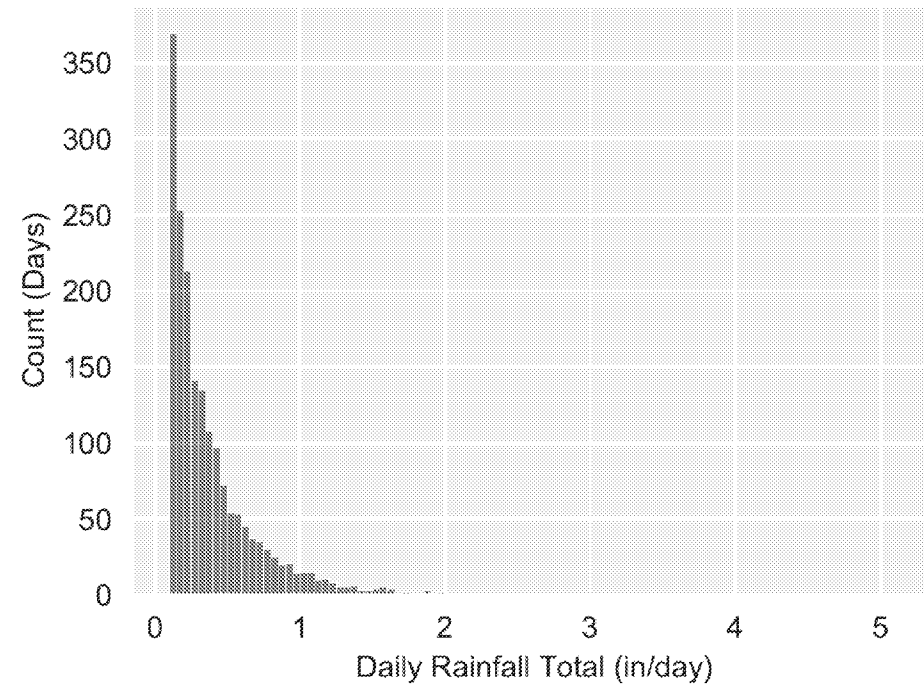
n	Min	Mean	Median	90 <sup>th</sup> Percentile
6,939	157	981	694	1961

# Distribution of Rainfall Tukwila Rain Guage 2001 - 2019

All Days



Days with more than 0.1 in/day



## Daily Precipitation (in)

	n	Mean	Median	90 <sup>th</sup> Percentile
All Days	6921	0.11	0.0	0.36
Days with more the 0.1 in	1834	0.40	0.28	0.82

# Bubble Plot Notes

- Centrifuge and filter solids only
- Total PCBs include Ecology Aroclors

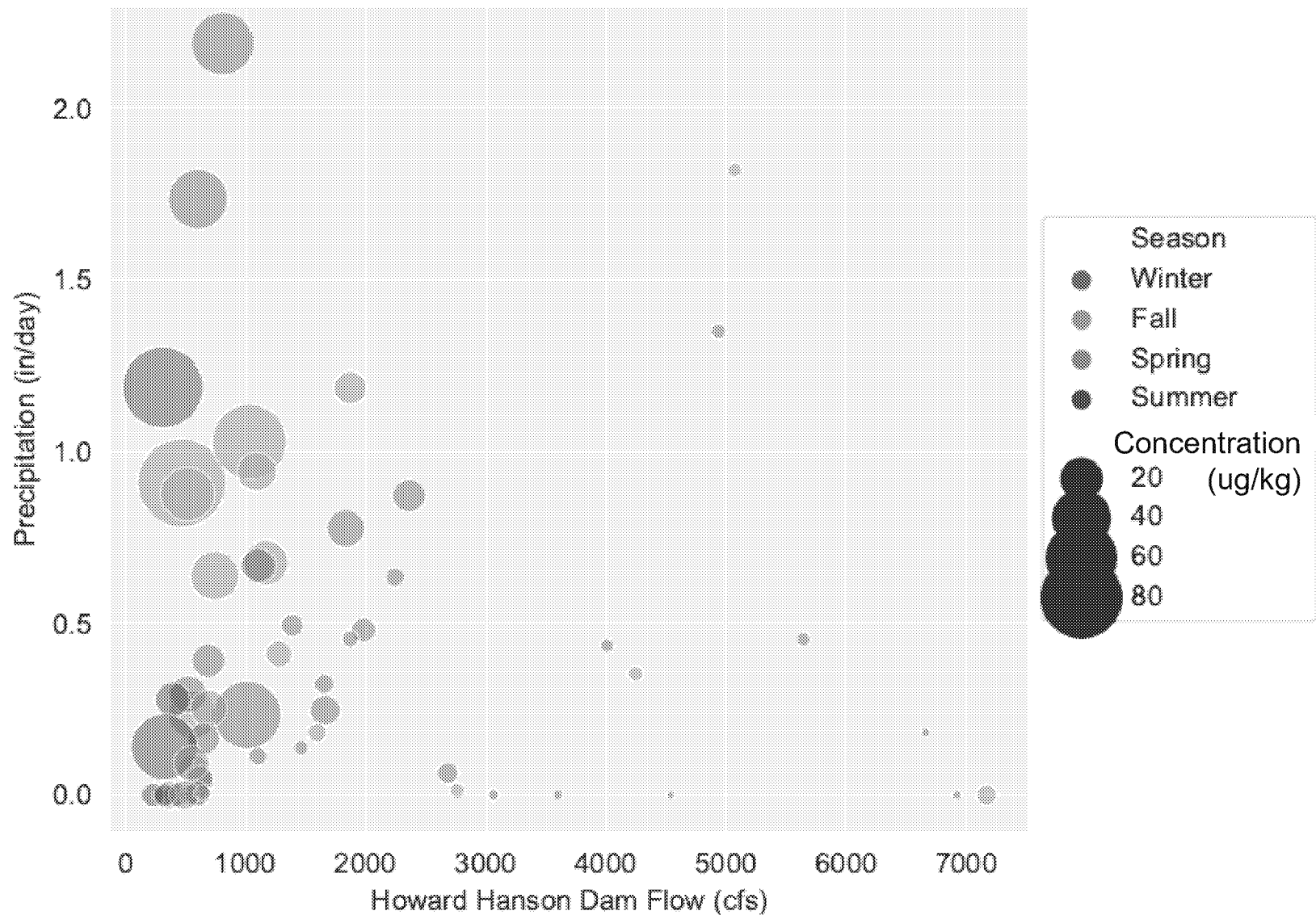
**X** = Flow below the Howard Hanson Dam (average during sampling)

**Y** = precipitation during and 12 hours before sampling (Tukwila rain gauge)

**Size** = Concentration

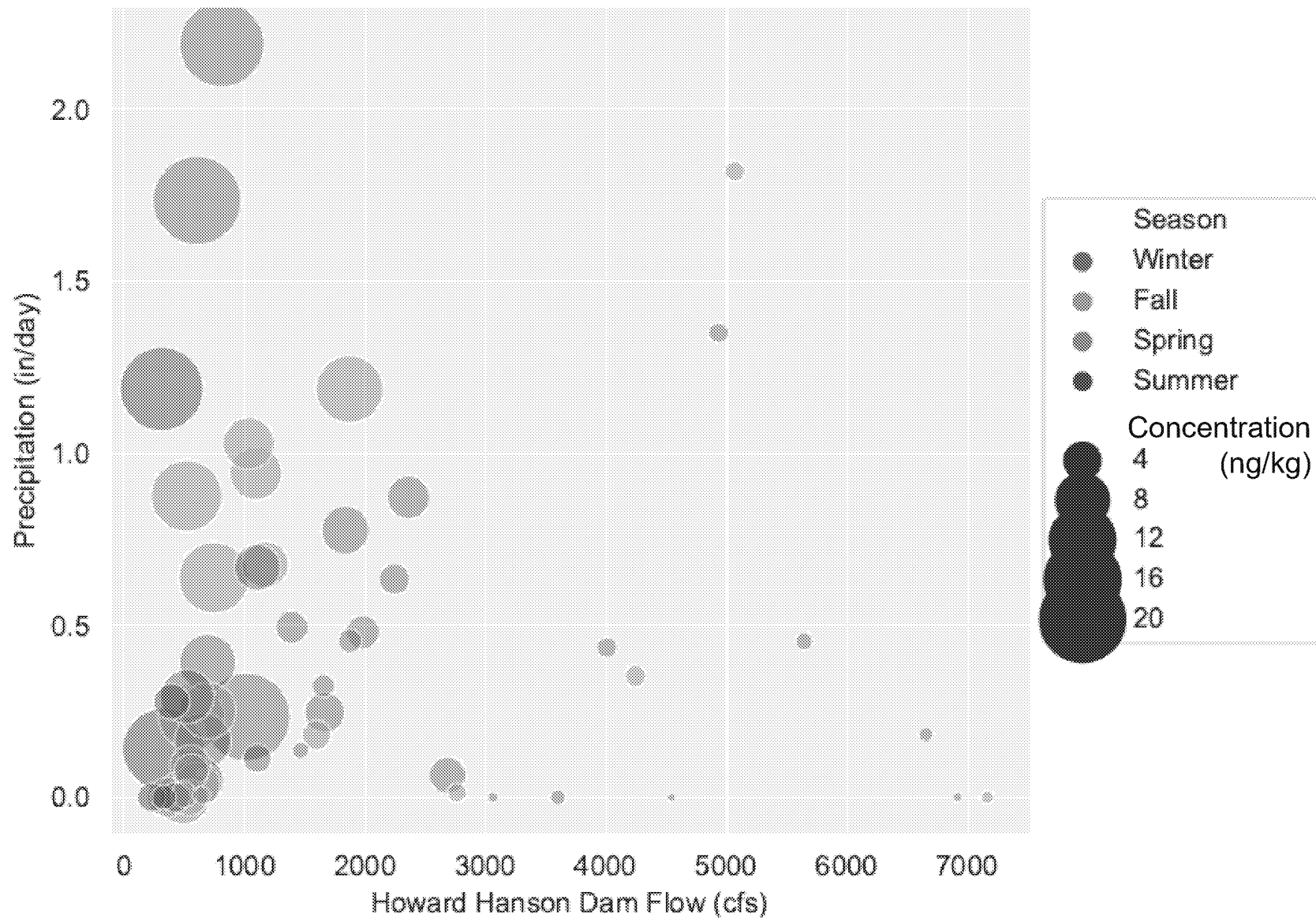
**Color** = Season

# Total PCBs – Higher Concentrations in Suspended Solids During Low Flow with Precipitation

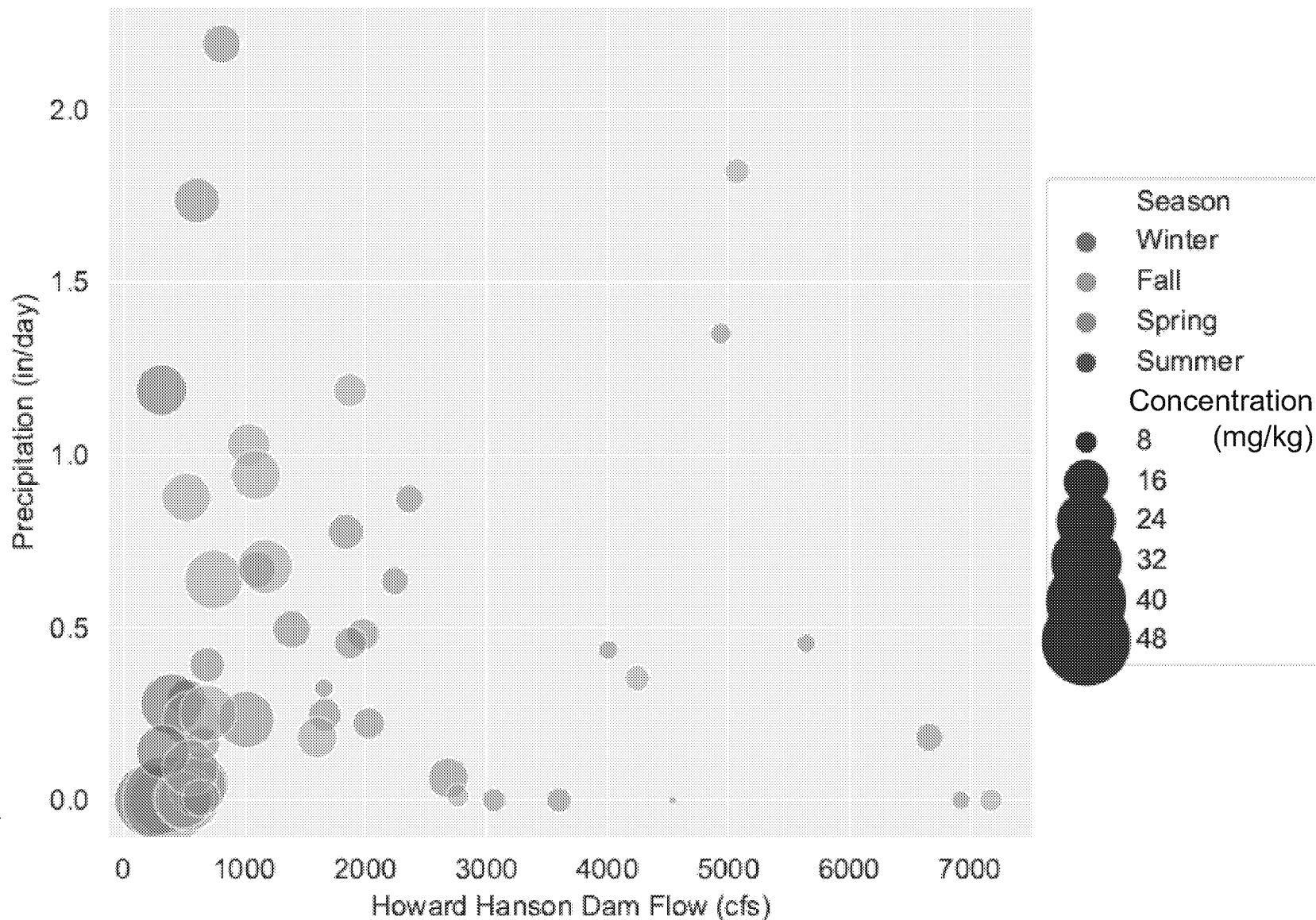




# Dioxin/Furan TEQ – Higher Concentrations in Suspended Solids During Low Flow with Precipitation



# Arsenic – Higher Concentrations In Suspended Solids During Low Flow without Precipitation



# Five Highest Samples for Each COC

Chemical	Concentration	Month	Season	Flow Below the Howard Hanson		Precipitation		Event Type
				(cfs)	(pctl)	(in/day)	(pctl)	
Total PCB (ug/kg)	99.8	October 2015	Fall	468	32	0.91	98	Storm
	84.1	July 2014	Summer	310	16	1.19	99	Storm - Dry Anteced
	71.7	October 2014	Fall	1031	69	1.03	98	Storm
	59.1	February 2013	Winter	1012	68	0.23	84	Storm - Dry Anteced
	56.0	August 2008	Summer	323	18	0.14	77	Storm
Dioxin/Furan TEQ (ng/kg)	21.7	January 2017	Winter	604	44	1.73	100	Storm
	21.5	February 2013	Winter	1012	68	0.23	84	Storm - Dry Anteced
	20.0	February 2017	Winter	808	58	2.19	100	Storm
	19.3	July 2014	Summer	310	16	1.19	99	Storm - Dry Anteced
	18.5	August 2008	Summer	323	18	0.14	77	Storm
Arsenic (mg/kg)	50.8	September 2015	Fall	357	23	0.00	27	Baseflow
	36.9	June 2015	Summer	228	3	0.00	27	Baseflow - Dry Anteced
	32.0	August 2013	Summer	327	19	0.00	27	Baseflow - Dry Anteced
	28.0	October 2014	Fall	536	38	0.00	27	Baseflow
	27.1	September 2016	Summer	393	26	0.28	86	Storm

- Flow and precipitation percentiles based on the 2001 – 2019 dataset
- Dry antecedent designation based on the 2 weeks before the sampling event (with a 1-day buffer added prior to sampling) that is <20<sup>th</sup> percentile of two-week precipitation (<0.015/day).

# Review of High Values

Chemical	n	Mean	Median	90th Percentile	UCL 95
Total PCBs (ug/kg)	65	15.5	8.3	41.7	19.7
	64 (1 excluded)	14.2	8.0	34.5	18.0
	63 (2 excluded)	13.1	7.7	30.8	16.4
Dioxin/furan TEQ (ng/kg)	59	5.8	4.0	14.2	7.0
	58 (1 excluded)	5.5	3.9	13.2	6.7
	57 (2 excluded)	5.2	3.8	12.5	6.3
Arsenic (mg/kg)	61	16.2	13.7	26.0	18.0
	60 (1 excluded)	15.6	13.6	25.9	17.2
	59(1 excluded)	15.2	13.5	25.7	16.7

- Total PCBs includes Ecology Aroclors
- Includes sediment traps
- Not fines-normalized or screened for low fines

# Work Products for Meeting #3